Contents

Section 19

Southeast Colorado River Basin

Utah State Water Plan

Groundwater

19.1 INTRODUCTION

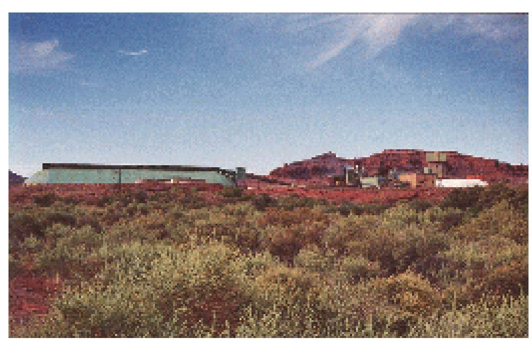
This section of the Southeast Colorado River Basin Plan discusses the groundwater resources. The development and management of groundwater is more complex than surface water. While surface water occurs in readily discernible drainage basins with topographic boundaries, groundwater occurs in aquifers that are hidden from view. The boundaries of an aquifer are physical, thus they may outcrop, be offset by faulting against an impermeable rock unit, may grade laterally into a lower permeability deposit due to changes in the depositional environment, or they may thin and disappear. At any given location, the land surface may be underlain by several aquifers. Each aquifer may have a different chemical quality and a different hydraulic potential. Each of these aquifers may be recharged in different locations and flow in different directions. Groundwater divides do not necessarily coincide with surface water divides.

Groundwater has been developed from two types of aquifers, consolidated rock and unconsolidated alluvial deposits. Water-yielding consolidated rock units underlie most of the basin at varying depths. In most areas, unconsolidated alluvial deposits are thin and of limited extent. Only in Castle Valley and Spanish Valley is much water produced from the alluvial aquifer.

19.2 AQUIFER CHARACTERISTICS

Alluvial aquifers are shallow and thus often closely connected to surface water sources making them susceptible to contamination. Consolidated aquifers are generally deeper and more expensive to develop. They also tend to be more distantly connected to sources of recharge but less liable to become contaminated from human sources. The important consolidated rock aquifers in the Southeast Colorado Basin are rocks of Mesozoic age, although the Cutler Formation of Paleozoic age is important locally. The aquifer properties of the Mesozoic rocks are given in Table 19-1. Younger rocks are only locally preserved while most rocks older than Mesozoic age contain brackish or saline water. The geologic stratigraphy is shown on Figure 3-3.

> Groundwater is an unseen, complex resource found in many locations but often difficult to develop.



Moab Salt Incorporated

Table 19-1
CHARACTERISTICS OF AQUIFERS OF MESOZOIC AGE

Aquifer[a]	Formation	Permeability (ft/d)	Transmissivity (ft^2/d)	Storage Coefficient
D	Dakota-Cedar Mountain	0.5 to 50	5 to 2,000	NA
D	Burro Canyon	NA[b]	NA	NA
M	Morrison	0.5 to 5	50 to 80	NA
M	Bluff	NA	NA	NA
N	Entrada	0.5 to 50	5 to 200	0.0001
N	Carmel	0.5 to 500	11 to 200	0.0001
N	Navajo	0.5 to 50	1 to 5,500	0.001 to 0.1
N	Kayenta	0.5 to 5	NA	NA
N	Wingate	0.5 to 50	NA	NA
	Chinle	0.5 to 5	NA	NA
	Moenkopi	0.5 to 5	5 to 270	0.0001

Source: Schlotthauer & others, 1981, Table 9.
[a]USGS aquifer designation from Avery (1986). Also see Figure 3-3.
[b]NA = Data not available.

19.2.1 Consolidated Rock Aquifers

All of the consolidated rocks can be water bearing to some degree depending on permeability, thickness and location with respect to recharge areas. Some of the consolidated rock aquifers contain good quality water although many yield water that is more saline. The U.S. Geological Survey has grouped these formations into regional aquifer systems in the San Juan County area with each group containing one or more formations.[21] These hydrologic units from oldest to youngest are: **P aquifer, C aquifer, N aquifer, M aquifer and D aquifer.** Also see Figure 3-3. There has also been some grouping of these formations in the Grand County area.[36]

P and C aquifers (Cutler formation) - The Cutler formation of Paleozoic age and primarily the **Cedar Mesa sandstone** member provides small quantities of water to seeps and springs on Cedar Mesa and in parts of Canyonlands National Park. The Cedar Mesa sandstone member is a fine-to coarse-grained, thickly cross-bedded, eolian deposition in a shallow-marine foreshore environment. It is an important aquifer in San Juan County.

The **White Rim sandstone** is medium-to coarse-grained, well-sorted and is the nearshore and sandbar-complex facies. It provides small quantities of water to springs and seeps on Cedar Mesa and in parts of Canyonlands National Park. There are also three wells in the White Rim sandstone in Canyonlands National Park. However, in most of the basin, it is either elevated or drained and contains little developable water, or it contains brackish water. It may yield water to wells recharged locally, such as along the margins of Castle Valley.

N aquifer (Wingate, Kayenta, Navajo, Carmel and Entrada formations) - The **Wingate sandstone** is a massive, fine grained, thickly cross-bedded, eolian sandstone. It erodes to vertical cliffs which are commonly coated with a dusky-red desert varnish. Thickness of the Wingate sandstone ranges from about 300 to 400 feet. It yields water to springs and wells where permeability has been enhanced by fracturing.

The **Kayenta formation** is an irregularly interbedded, fluvial fine to coarse-grained sandstone, siltstone and shale. Thin beds of shale-pellet conglomerate and freshwater limestone are present locally. The sandstone facies predominate. In many places there is a prominent siltstone bed near the top of the formation which locally perches water in the overlying parts of the Kayenta formation and the Navajo sandstone. The Kayenta formation erodes to cliffs and benches and caps many mesas and narrow benches. Thickness of the Kayenta formation is about 240 feet in the western part of the Grand County area and decreases to nearly zero as it moves east in the eastern part of the area.

The **Navajo sandstone** is the most prolific water-yielding formation. This formation is one of the shallowest and most permeable in the Grand County area, while in most of San Juan County, the Navajo sandstone is covered by younger formations. It produces water with low total dissolved-solids concentrations and is therefore a prime source of drinking water. Near Bluff, some wells in the Navajo sandstone exceed drinking water standards in arsenic.[21]

The Navajo sandstone is a massive, fine grained, thickly cross-bedded sandstone of windblown origin. It erodes to massive cliffs and domes alternating with depressions. The thickness of the Navajo sandstone is about 400 feet in the western part of the Grand County area and decreases to the east. The Navajo sandstone is absent in the extreme eastern part of the area.

The **Carmel formation** crops out south of the City of Green River but pinches out towards the eastern part of Grand County. This formation is a confining unit and is not known to yield water. The Carmel formation has created flowing-well conditions in Gothic Creek Wash south of Bluff where it confines water in the underlying Navajo sandstone.

The **Entrada sandstone** is divided into three members: the Dewey Bridge, Slick Rock and the Moab sandstone members. The Dewey Bridge member is composed of siltstone and fine grained sandstone. The Slick Rock member is a massive, medium grained, cross-bedded sandstone of windblown origin. The Moab sandstone member is a single crossbed set of medium grained, massive sandstone at the top of the formation. Thickness of the Entrada sandstone is as much as 550 feet in the western part of the area and decreases to the east.

The **D aquifer** - The **Dakota sandstone and Burro Canyon sandstone** provide the principal groundwater source near Blanding and Monticello. Where recharged locally, they yield water of good quality. Because they do not have much storage, individual well yields are small.

19.2.2 Alluvial Aquifers

Alluvial aquifers are generally characterized by high transmissivities (up to 14,000 ft^2/yr) and high storage coefficients (up to 20 percent). Alluvial fills occur along existing rivers and streams where water is actively moving and depositing sand and gravel. The occurrence of alluvial aquifers in the basin is minimal with water-bearing depths of less than 200 feet in most areas. The largest and most developed alluvial aquifers are in Spanish Valley, Castle Valley and the flood plain of the San Juan River near Bluff.

19.3 STRUCTURAL SUBDIVISIONS

The permeability of aquifer rocks and their position with respect to natural recharge and discharge is determined by geologic structure. The distribution and thickness of unconsolidated alluvial deposits is likewise a function of geologically recent structural adjustments of the earth's crust. The Southeast Colorado River Basin can be subdivided into structural provinces as shown in Figure 19-1.

19.3.1 Green River Desert and Uncompahgre Uplift

Little exploration has taken place in the Green River Desert and Uncompahgre Uplift. As a result, little is known of local aquifer characteristics or groundwater production.

19.3.2 Salt Anticlines

The northern part of the area is characterized by several northwest-southeast trending valleys and alluvial basins formed by the upwelling of deeply buried salt formations. These include Salt Valley of Arches National Park, Castle Valley, Spanish Valley and Paradox Valley. Some, such as Salt Valley, are cored by salt at or near the surface, and groundwater is saline (Rush and others, 1980). Where such structures are crossed by the Colorado River, such as Castle Valley and Spanish Valley, the near-surface salt has been dissolved and replaced by thick deposits of alluvial sand and gravel. These alluvial deposits contain groundwater of varying quality depending on location with respect to recharge or to remaining salt bodies.

19.3.3 Laccolithic Domes

The laccolithic La Sal, Abajo (Blue) and Navajo mountains are igneous intrusions which have domed the overlying sedimentary layers. Although their elevation enhances the potential for recharge, aquifers above the Navajo sandstone are generally at high elevations, dip away from the mountains, are drained, and well

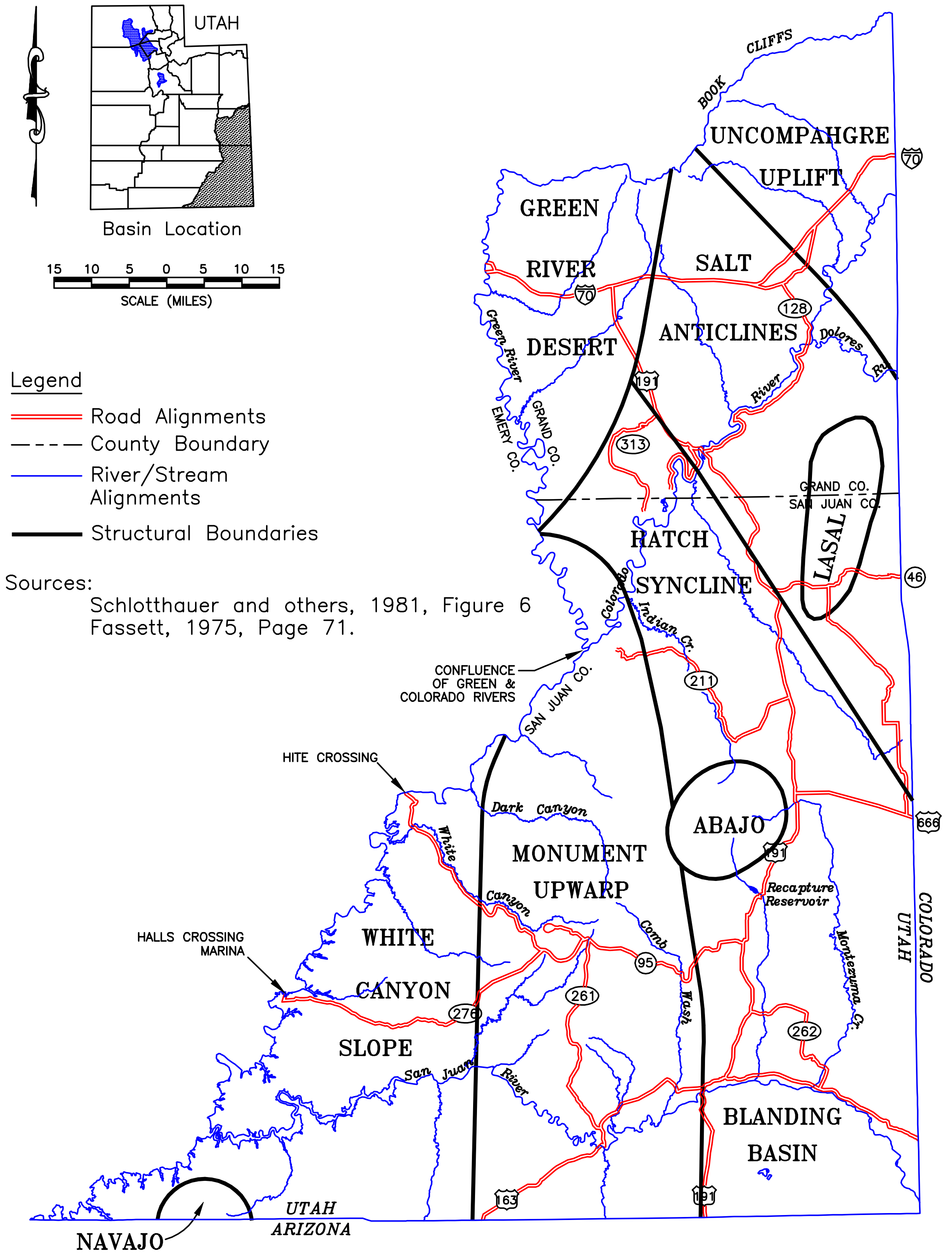
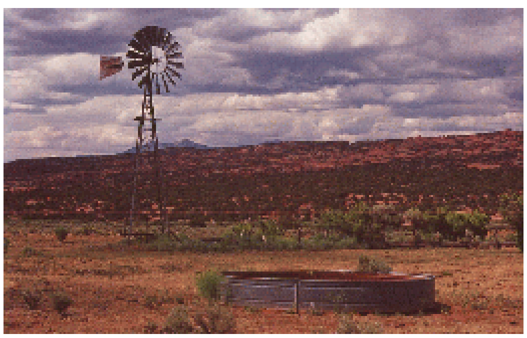


Figure 19–1
GEOLOGICAL STRUCTURAL ELEMENTS
Southeast Colorado River Basin

yields are low. Near Moab, the Navajo sandstone is well exposed at moderate elevations, receives abundant recharge from streams draining the La Sal Mountains, is well fractured, and yields water readily to wells. Most of the intrusions of the Abajo Mountains are above the elevation of the Navajo sandstone and deeper formations preventing recharge.

19.3.4 Hatch Syncline and Blanding Basin

A structural basin containing most of the Mesozoic aquifer units extends SSE from the Colorado River to Bluff. Because it is a plateau cut by canyons, the aquifers above the Carmel formation are drained or only partly saturated. Wells in the Dakota and Burro Canyon formations at Monticello and Blanding yield small to moderate amounts of fresh water.



Windmill pumps water for livestock

Tests of the Navajo sandstone near Monticello and Blanding have been disappointing, with deep static levels and low yields. At the elevation of Bluff near the San Juan River, the Navajo sandstone has artesian pressure and is a good producer. The Cutler formation of Paleozoic age is deeply buried in the Blanding basin and contains brackish or saline water. The Cutler formation is exposed to the north in Canyonlands National Park. Where it is recharged locally, it produces small amounts of fresh water.

19.3.5 Monument Upwarp

Little exploration has taken place in the Monument Upwarp. It can be seen as a large blank area (Weigel, 1987). The Mesozoic aquifers have been uplifted and mostly eroded. Erosional remnants cut by canyons are well drained. The underlying Paleozoic rocks generally have poor quality water with limited recharge by overlying streams.

19.3.6 White Canyon Slope

On the White Canyon Slope, rock layers dip gently westward toward Lake Powell from the Monument Upwarp. Little exploration has occurred in this unpopulated region. Groundwater is likely available where Mesozoic or Paleozoic aquifers are recharged from Lake Powell.

19.3.7 Navajo Nation Lands

The portions of Utah classified as the Blanding Basin, Monument Upwarp and White Canyon Slope and lying mostly south of the San Juan River are on Navajo Nation lands. Water development here has been the province of federal agencies, and the state of Utah has had little opportunity to participate. Data on groundwater on Navajo Nation land can be found in Avery, 1986 [21] and USGS, 1963.[59]

19.4 SALT AND BRINE

The Southeast Colorado River Basin is underlain by the Paradox formation which consists largely of evaporite deposits. Evaporites are soluble minerals evaporated from an ancient sea and contain sodium and potassium salts as well as gypsum. In contact with groundwater, these minerals dissolve to form brine. Studies by the U.S. Geological survey show that the eastern two-thirds of San Juan County is underlain by a thick layer of briney groundwater with a total dissolved solids concentration greater than 10,000 mg/l. The top of this brine layer ranges in elevation from below sea level to 6,540 feet.

Where the salt is near the surface, as in Castle Valley, Spanish Valley and Paradox Valley, it may come in contact with circulating groundwater. As a result, changing prehistoric groundwater gradients or aquifer pressures by pumping creates the potential for aquifer contamination by salt water intrusion.

Salt water intrusion is apparently occurring in the Aneth area where salinity has been increasing in several wells in the Navajo sandstone aquifer. An analysis of this problem has shown that the contaminating salt is not from the oil field brine which is re-injected into the oil reservoirs, but is probably from the upper paleozoic briney aquifer which underlies the Navajo sandstone even though it is separated by one or more confining layers.[20] The brine may be reaching the Navajo sandstone through a breach in the intervening confining layers which could be either natural fractures, abandoned drill holes or poorly cemented casings of oil wells.

19.5 GROUNDWATER WITHDRAWALS

Division of Water Rights public supply records from reporting communities indicate about 6,046 acre-feet are annually withdrawn from wells and springs in the basin. These data are shown in Table 19-2. This table does not include several towns or communities (Aneth, Blanding, Monticello) which have not reported well pumpage and does not include pumpage from private domestic wells which is a significant part of the total supply in some communities. The natural discharge of many unmonitored springs also is not included. The total groundwater diversions as determined during the Division of Water Resources M&I inventories and from Navajo Nation data indicate the total diversions were: springs, 2,770 acre-feet and wells, 12,220 acre-feet.[14,15,84] Also see Table 5-4. Figures 19-2 and 19-3 show location of springs and wells.

19.6 CONSOLIDATED ROCK GROUNDWATER DEVELOPMENT POTENTIAL[21,23,25,34,35,36]

The groundwater aquifers are found at varying depths over large areas of the basin. They include rocks from Cretaceous to Permian age, although not all formations are present in all areas. In general, the shallower aquifers nearer to the recharge areas contain better quality water. A brief discussion of each system from oldest to youngest follows:

P and C Aquifers (Lower Permian Cutler formation) - The Cutler formation underlies most of the basin, often at depths which along with poor water quality, often makes development unfeasible. In San Juan County, the **P Aquifer** consists of the Cedar Mesa sandstone and the **C Aquifer** consists of the DeChelly sandstone. Both the Cedar Mesa sandstone and the White Rim sandstone members of the Cutler formation yield water to wells in the Needles area of Canyonlands National Park and near the confluence of the Green River with the Colorado River. Additional wells could produce small quantities of water.

The **P Aquifer** or undifferentiated Cutler formation in Castle Valley furnishes water to about 30 wells along the west side at depths of 150 to 300 feet where there is a possible hydraulic connection to the salt layers of the Paradox formation. Five wells each discharge from 20 to 40 gallons per minute. Some of the wells are unsuitable for domestic use without treatment. There is also some use in the Needles area of the Canyonlands National Park.

The **C Aquifer** or De Chelly sandstone is the only source of water in some of the Navajo Nation chapters. The groundwater moves northward from Arizona towards the San Juan River.

N Aquifer (Middle and Lower Jurassic Entrada sandstone, Carmel formation, Navajo sandstone, Kayenta formation and Wingate sandstone) - The **N Aquifer** is the main aquifer throughout the basin. The Navajo sandstone, Kayenta formation and Wingate sandstone form the Glen Canyon Aquifer found in the southern half of Grand County, primarily in the Spanish Valley/Moab area. The Entrada sandstone and Carmel formation are part of the **N Aquifer** in middle and southern San Juan County. Where

Table 19-2
Estimated Annual Groundwater Diversions

Entity	Sources	Diversion (acre-feet)	Year
Grand County			
Grand County WCD	6 wells	1,111	1996
Moab City	3 springs, 5 wells	2,032	1996
NPS Arches	2 wells	6	1996
Grand County Subtotal		**3,149**	
San Juan County			
Blanding	4 wells used for irrigation of parks and golf courses	ND	
Bluff	3 wells	61	1996
Eastland SSD	3 wells	9	1996
Mexican Hat	2 wells	28	1995
Mexican Hat (SJSSD#1)	1 well	34	1995
Monticello Municipal	6 wells	ND	
NPS Halls Crossing Marina	2 wells	0.3	1996
NPS Hite Marina	NA	12	1996
Self-supplied industry	well	997	1996
San Juan Co Subtotal		**1,141**	
NTUA			
Aneth Community	Wells	144	1996
Montezuma Creek Comm	Wells	1,612	1996
NTUA Subtotal		**1,756**	
Basin Total		**6,046**	

Source: State Engineer's Public Supply Records

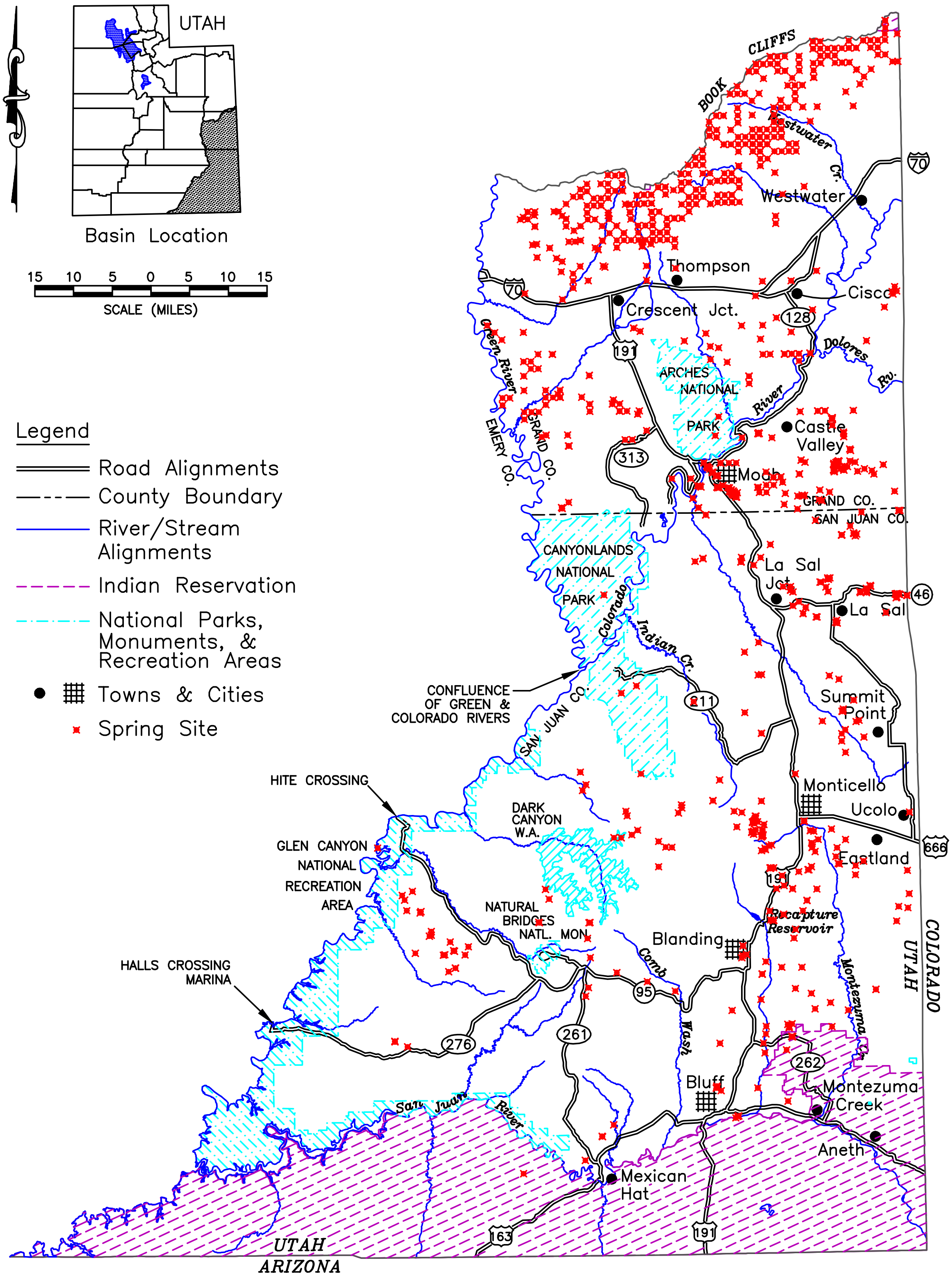


Figure 19-2
SPRING LOCATIONS
Southeast Colorado River Basin

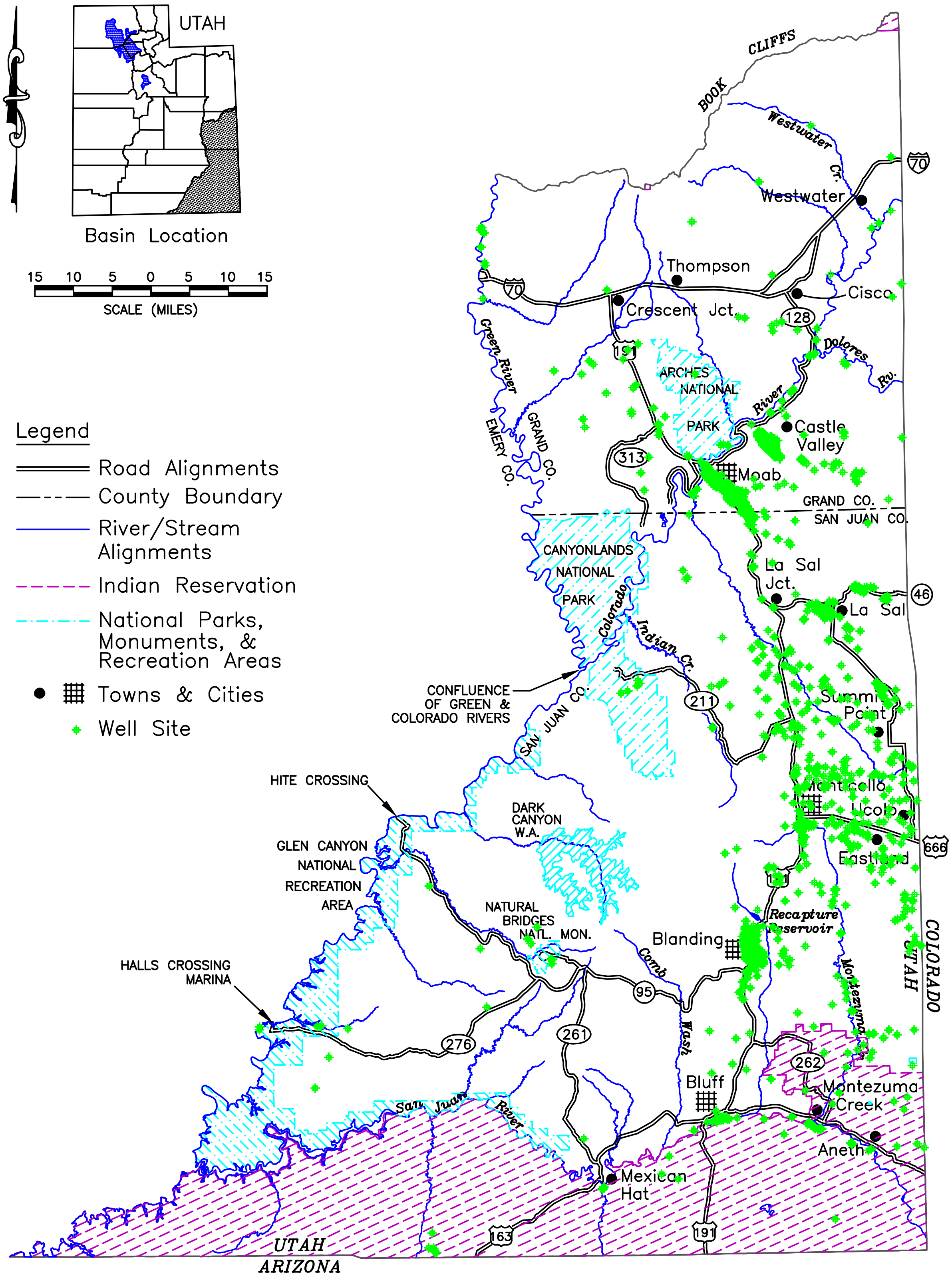


Figure 19-3
WELL LOCATIONS
Southeast Colorado River Basin

the Navajo sandstone and Kayenta formation are flat lying, springs issue from the base of the Navajo sandstone. Spring discharge ranges from less than 5 to more than 300 gpm. Well discharge is as much as 2,500 gpm in the Spanish Valley/Moab area. The **N Aquifer** is a major or only source of water in Bluff, Eastland, the Spanish Valley /Moab area, and the Aneth, Mexican Water and Red Mesa chapters of the Navajo Nation. The water is suitable for culinary use. There is potential for development of about 5,000 acre-feet annually along the San Juan River corridor from Aneth to Bluff. There is also potential for drilling wells in the Eastland area and on White Mesa. The Glen Canyon Aquifer in the Spanish Valley/Moab area is a potential source for additional development of groundwater.

M Aquifer (Upper Jurassic Morrison formation) - This aquifer includes the Bluff sandstone and Westwater Canyon, Recapture, and Saltwash members of the Morrison formation. Recharge areas are found in the Book Cliffs, on the flanks of the La Sal Mountains, in Montezuma Creek Canyon and other canyons north of Bluff, and in areas south of the San Juan River. The best potential use is for private domestic wells and stock wells in southeastern and northeastern San Juan County and southeastern Grand County. The more likely areas are south of the high mesas in central San Juan County and north of the San Juan River where the **D Aquifer** is missing and the **N Aquifer** is deep. Yields will be low. The Saltwash member yields small quantities of water to seeps and springs northwest of Moab.

D Aquifer (Cretaceous Dakota sandstone and Burro Canyon formation) - This aquifer is exposed in the Book Cliffs area, in the La Sal area, around Monticello and in the Sage Plain, and near Blanding and in the White Mesa area. It is covered by alluvial deposits on the flanks of the La Sal and Abajo mountains. In other areas, it is overlain by the Mancos shale which prevents recharge. Annual recharge is estimated at about 39,000 acre-feet in the San Juan County area. The water quality varies. The **D aquifer** is found around Blanding, Eastland, La Sal and Monticello. Wells exist in the Blanding and Monticello areas along with private domestic wells in east-central and northeastern San Juan County and southeastern Grand County. It also yields water to a few small springs. Yields are low and the aquifer could be easily mined by excessive pumping.

19.7 CASTLE VALLEY ALLUVIAL AQUIFER[29,35]

Castle Valley is a collapsed salt anticline lying between the La Sal Mountains and the Colorado River. The cliffs of Porcupine Rim and Parriott and Adobe mesas define the southwest and northeast borders respectively.

Hydrogeology - Castle Valley is surrounded by Permian to Tertiary sedimentary and igneous rocks. It is part of a large, regional collapsed salt anticline that includes Paradox Valley to the southeast.

The valley fill consists of alluvial-fan deposits and stream alluvium. Holocene stream deposits along Castle Creek and Placer Creek are generally poorly sorted sand, silt and clay with some gravel lenses, particularly in the higher reaches. Course-grained older alluvium is exposed in the higher parts of Castle Valley and in the valley proper. Alluvial-fan deposits form apron-like gentle slopes at the base of Porcupine Rim consisting of poorly sorted boulders, cobbles and gravels in a fine-grained matrix.

Groundwater is found in both fractured rock and valley fill. Most of the water entering the local aquifers falls initially as snow in the La Sal Mountains. All of the homes in the valley use groundwater for both culinary and secondary uses. However, high mineral content at some wells has been a problem in terms of drinking water standards.

Groundwater Quality - The quality of groundwater in Castle Valley varies widely depending on well location and aquifer type. Most of the groundwater in the alluvial aquifer is classified as either Class IA or II. Wells sampled in this aquifer ranged from 357 micromhos/cm (211 mg/L) to 1,960 michromhos/cm (1,156 mg/L).[36] Water in the Cutler formation aquifer is mostly Class II but in some areas may be Class III with specific conductance as high as 3,260 µS/cm (1,923 mg/L). Refer to Table 12-2 for more information. The source of dissolved-solids is assumed to be remnants of Paradox evaporites within the core of the anticline. A few wells in the Cutler formation have been identified as producing water with excessive concentrations of selenium and sulfate. The probable cause of the poor water quality is assumed to be associated with a long aquifer residence time and related flow path, dissolved fine-grained constituents of the Cutler formation, and the hydraulic connection to the Paradox formation evaporites beneath the Cutler formation.

Recharge and Discharge - Approximately 30 wells receive water from the Cutler formation aquifer along the base of Porcupine Rim on the west side of the Valley. Well depths are generally 150 to 300 feet below land surface. Recharge to the aquifer is partially from the La Sal Mountains. The Chinle and Moenkopi formations are important confining units overlying the Cutler formation. Regionally, the Wingate sandstone is an important fractured rock aquifer, but exposures in Castle Valley are too localized and do not receive sufficient recharge.

Measured potentiometric surface elevations have indicated that groundwater flow patterns generally follow a northwest direction paralleling Castle and Placer creeks. Most of the recharge to the valley fill aquifer is from Castle and Placer creeks which originate high in the La Sal Mountains. As Castle Creek crosses the coarse-grained valley fill in the southeastern part of the valley, much of the flow percolates into the aquifer. Castle Creek is a losing stream except near the town of Castle Valley. Other sources of local groundwater recharge include direct percolation of precipitation, percolation and seepage of irrigation water, and inflow from adjacent fractured rock aquifers. Aquifer discharge is to local irrigation canals that intercept groundwater tables, wells, evapotranspiration of shallow groundwater aquifers, and underflow to the Colorado River.

One study has just been completed to determine the impacts of the wells and septic tanks on the alluvial aquifer.[29] Another study is under way to determine the impact of a growing population.

19.8 SPANISH VALLEY ALLUVIAL AQUIFER[23,25,36]

The Mill Creek and Spanish Valley drainage includes an estimated 44 square miles of land southeast of Moab and is one of the more developed areas in the Southeast Colorado River Basin. Water for both irrigated agriculture and municipal uses has been developed from surface and groundwater sources. However, groundwater is the primary source of culinary water.

Hydrogeology - The local groundwater system has a complex hydrogeologic makeup and consists of both alluvium and consolidated rock. These aquifer materials include the **N aquifer** (Navajo, Kayenta, and Wingate sandstone formations; also called the Glen Canyon Group).

Groundwater Quality - Groundwater quality is generally good with only moderate concentrations of dissolved solids and sulfates. However, these levels increase at various locations within the local aquifer.

Water quality characteristics typical of water in the Entrada, Navajo and Wingate sandstone aquifers include low to moderate concentrations of dissolved solids, calcium bicarbonate and calcium magnesium bicarbonate. Dissolved-solid concentrations are typically in the range of 200 to 300 milligrams per liter and the water is considered hard. Concentrations of dissolved-solids and sulfate increases west and south of the City of

Moab's well field. This is because an increasingly larger proportion of the groundwater comes from alluvium in upper Spanish Valley, which probably contains remnants of evaporates in the core of the anticline. Concentrations of dissolved solids in the Navajo sandstone aquifer also are higher along the Moab fault, suggesting that the fault penetrates to the deeper brine-bearing formations.

Recharge and Discharge - Recharge to the consolidated rock aquifers typically occurs where the formations crop out or are overlain by unconsolidated sand deposits. Recharge is enhanced where the sand deposits are saturated at a depth of more than about six feet below the land surface as the effects of evaporation decreases rapidly with depth. Recharge to the Wingate sandstone aquifer typically occurs by downward movement of water from the Navajo sandstone aquifer through the Kayenta formation, and primarily occurs where the Navajo sandstone, Kayenta formation and the Wingate sandstone are fractured.

The principal area of discharge from the Navajo sandstone aquifer in the Mill Creek-Spanish Valley area occurs in and near the City of Moab's well field, near the northeast canyon wall of Spanish Valley. Discharge from one well is reportedly as large as 2,000 gallons per minute, and discharge from one spring near the well field is reportedly over 300 gallons per minute.

Discharge from springs issuing from the **N aquifer** typically is less than about 10 gallons per minute and discharge from wells ranges from 5 to 30 gallons per minute. In the Mill Creek-Spanish Valley area, discharge from springs issuing from the **N aquifer** ranges from 15 to over 300 gallons per minute and discharge from wells ranges from less than 10 to about 2,000 gallons per minute. The larger discharge rates occur where the formations are fractured and faulted. Water levels declined from the early 1960s to about 1979, and then rose as much as 39.5 feet from 1979 to 1987. The larger than normal amount of precipitation beginning in 1977 probably is a substantial factor in the rising water levels.

In addition and on an annual basis, substantial groundwater draw down is experienced at the Moab well fields toward the late summer months with subsequent recovery during the fall to early summer months. As a result, it is believed that the long-term change in storage in the local reservoir is minimal with groundwater levels fluctuating in near direct response to annual precipitation and rate of pumpage. The 1996 rate of annual pumpage and spring diversions for culinary water demand was over 2,100 acre-feet in the Moab-Spanish Valley area.

19.9 POLICY ISSUES AND RECOMMENDATIONS

The major groundwater issues center around the development of long-range groundwater management and development plans.

19.9.1 Development of Long Range Groundwater Management Plans

Issue - A long-range groundwater master plan is needed to identify potential contamination problems and to establish necessary management criteria.

Discussion - Groundwater is an important source of culinary water in the basin and will become more so in the future. Instances of excessive groundwater level draw-down and water quality problems have been identified and attributed to population growth. More detailed assessments of groundwater capacity and water quality projections need to be made. In the more populated areas including Moab, Castle Valley, Blanding and the Navajo Nation, comprehensive groundwater management plans should be prepared to adequately assess: 1) The ability of local aquifers to meet projected demands; and, 2) the impact on continued residential development on groundwater quality.

Recommendation - Plans should be prepared for the total development of the groundwater resources in areas of high projected growth.

19.9.2 Need for Regional Groundwater Exploration and Inventory

Issue - The existing capability of local aquifers to provide a significant supply of water for future demands should be quantified.

Discussion - Because surface water supplies are limited, groundwater is a vital source for present and future supplies in the Southeast Colorado River Basin. Groundwater development, especially from the deeper bedrock aquifers, has been slow because of the expense and uncertainty of exploration.

The population of some communities is expected to increase so the present culinary water supply will not be adequate to meet the projected demand. Most of this water will probably come from groundwater aquifers. There is a need to obtain new "hard data" regarding the ability of various aquifers to yield culinary quality water. Some of the most recent data is nearly 15 years old and was not much beyond a reconnaissance level of study.

Groundwater studies are currently underway in Castle Valley and Spanish Valley. The Division of Water Rights is completing a study of the alluvial aquifer in Castle Valley to determine if the groundwater is being contaminated by septic systems, if the groundwater is being depleted and to prepare a water budget.

The Town of Castle Valley also has a study underway to explore the groundwater aquifers in more depth to determine future impacts of additional septic tank systems on groundwater development. This study is being carried out by the Division of Water Resources and the Utah Geological Survey in cooperation with other federal and state agencies.

A Regional Public Drinking Water Management Plan is being prepared for the Spanish Valley area with a block grant from the Department of Community and Economic Development. This study will determine if there is additional developable water in the aquifers that can be used by the Grand Water and Sewer Service Agency and the City of Moab to meet future culinary water demands.

Recommendation - The state should provide support to local entities by compiling existing groundwater information and by underwriting exploration programs where existing knowledge is insufficient to predict the quantity, quality, or production cost of developing new groundwater sources. ❑